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EXAMINER	
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 10/725,903	Applicant(s) WIENEKE, BERNHARD	
	Examiner CHIA-WEI A. CHEN	Art Unit 2622	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 21 January 2009.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-14 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-14 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 21 January 2009 has been entered.

Response to Arguments

2. Applicant's arguments filed 19 December 2008 have been fully considered but they are not persuasive.

Applicant argues with respect to amended claim 1, and makes an assertion that the McDowell reference performs a calibration “exclusively with the aid of a calibration plate” and therefore the McDowell reference does not read on the amended claim (see page 11 of Applicant’s Remarks).

However, neither Applicant’s amended claims nor the Specification of the application discloses any calibration made without a calibration plate.

In response to applicant's argument that the references fail to show certain features of applicant’s invention, it is noted that the features upon which applicant relies (i.e., a calibration performed without a calibration plate) are not recited in the rejected

claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

Applicant also argues with respect to amended claim 1 that McDowell teaches 3DPTV (3-Dimensional Particle Tracking Velocimetry) as opposed to the instant application's stereo-PIV (Particle Image Velocimetry).

However, there is no specific argument as to the reason Applicant believes the McDowell reference only applies to a 3DPTV flow analysis and not a stereo-PIV flow analysis. Only brief descriptions of the 3DPTV and stereo-PIV methods are provided in pages 11 and 12 of Applicant's arguments. There is no explanation as to why Applicant believes that the process described by the McDowell reference falls under either definition.

Nevertheless, Examiner respectfully disagrees. McDowell teaches a particle imaging velocimetry method in columns 6-8. As the Applicant describes in pages 11 and 12 of Arguments filed 19 December 2008, in the stereo-PIV method (particle image velocimetry), the movement of particles in a light section is determined, the light section being viewed through two cameras arranged at an angle to each other. McDowell teaches wherein the movement of particles in a light section is determined (see col. 6, lines 39-41: images of moving particles are captured in each camera's viewing plane), the light section being viewed through two cameras arranged at an angle to each other (see col. 4, lines 43-46: first and second cameras are positioned approximately

perpendicular to each other). According to the definition of stereo-PIV that the Applicant has provided on page 12 of Applicant's Remarks, McDowell clearly falls under this definition.

Applicant further argues that the term "correlate" used in the McDowell reference has nothing to do with the "cross-correlation" of the instant application. Rather, Applicant argues that the content of the description of columns 6 and 7 of the McDowell reference describes a means of triangulation, and thus the rejection of claim 1 should be withdrawn.

However, Examiner respectfully disagrees. Since Applicant has not provided a specific definition of "optical cross-correlation," a term that is the broadest reasonable interpretation is taken. The Office Action takes the term "optical cross-correlation" to mean the process in which points on individual imaging arrays from two or more individual cameras are correlated to form a point correspondence in an absolute coordinate system. The McDowell reference describes this process in col. 6, line 66 – col. 7, line 54. Furthermore, on page 8 of the Specification filed 1 December 2003, in the paragraph spanning lines 8-19, the Applicant uses a means of triangulation to determine the point correspondence of points detected by two cameras.

Applicant further argues that the instant application is differentiated from the McDowell reference in that the self-calibration of the instant application takes images of flow particles, and thus the rejection to amended claim 1 is traversed.

However, reading the claims in the broadest sense, the “flow particles” of amended claim 1 are interpreted as the tracer particles in the volume of flow as described in col. 7 of the McDowell reference. Furthermore, neither the amended claims nor the Specification of the application describe a calibration method wherein a calibration plate is removed, as Applicant asserts in Applicant’s Remarks.

Applicant asserts, on page 17 of Applicant’s Remarks, that col. 2, line 56 – col. 3, line 2 of McDowell are directed exclusively to the execution of a 3DPTV PIV method and that the description provided by the above passage of McDowell is no way related to the calibration.

However, Applicant gives no reason as to why Applicant believes this is the case. Furthermore, the citation of the passage is used to compare the “at least two cameras” of the originally presented claim 1 with the “two or more cameras” used in the stereo imaging velocimetry system of McDowell. A more clear citation of the cameras (col. 7, lines 1-13 of McDowell) used in the calibration process is provided in the present Office Action.

Applicant asserts, on page 18 of Applicant’s Remarks, that col. 3, lines 27-39 of McDowell do not teach wherein point correspondences are determined.

This limitation of the amended claim is addressed by col. 7, lines 1-46 of the McDowell reference. Although the cited passage in col. 3, lines 27-39 is directed

towards the operation of the PIV method, the corresponding steps of determining point correspondences in the calibration process is described in col. 7, lines 1-46.

Applicant further asserts that the determination of the imaging equation of the McDowell reference takes place after the actual calibration. Applicant points to col. 7, line 50 of the McDowell reference to emphasize that the image equation of McDowell is determined after the calibration procedure is completed.

However, Examiner respectfully disagrees with this reading of the McDowell reference. The calibration procedure of McDowell describes the determination of the internal and external camera parameters, including the pixel readout locations of predetermined calibration points as well as the focal lengths of each camera. After these calibration parameters are determined, a least squares approximation is used in combination with these determined calibration parameters to find the absolute coordinates of a particle with only its pixel position on the cameras. This is the imaging equation of the camera. That is, after the calibration is performed, only the pixel positions of a particle on left and right cameras must be known in order to determine the absolute coordinates of the particle. The Examiner believes that Applicant's argument here is only based on the semantics of the word "calibration." McDowell states that its imaging equation is determined after the "calibration" parameters are found, whereas the instant application includes the determination of the imaging equation along with the determination of the calibration parameters in its definition of the term "calibration process."

Thus, the rejection of amended claim 1 and its dependent claims are made under the McDowell reference.

Claim Rejections - 35 USC § 103

3. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

4. Claims 1-6, 9, and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over McDowell (US 5,905,568), previously cited in Office Action mailed 19 August 2008.

Claim 1, McDowell et al. teaches, in Fig. 4, a method for a performing stereo PIV on visualized flows, said method being comprised of:

providing first and second cameras (cameras 18 and 20, col. 7, lines 1-13) and one image sector, with the cameras, viewing approximately a same area of an illuminated section but from different directions (see cameras views 32 and 34 in Figs. 1A and 3);

performing, a volume calibration using a calibration plate on said first and second cameras to obtain internal and external imaging parameters (col. 7, line 55);

executing a self-calibration process prior to said performing said stereo PIV on visualized flows, said self-calibration process including optical cross-correlation (point

correspondences on the left and right views of left and right cameras are correlated with an absolute coordinate system; col. 7, lines 1-46) comprising:

taking first and second images (left and right views from left and right cameras; col. 7, lines 10-13) of flow particles in the same area using respectively said first and second cameras, the first and second images respectively being divided into individual sections (left and right imaging elements are pixel arrays, i.e., individual sections; see Figs. 1B, 1C, and 3) which are respectively interrogation areas;

determining corresponding correlating ones of said interrogation areas respectively in the first image and the second image such that at least first and second corresponding correlating interrogation areas respectively of said first and second images are identified (A ray of light 46 leaves a tracer particle and strikes the right camera pixel array 32 at location x^i_R, Z^i_R which corresponds to a ray of light 54 leaving the same tracer particle and strikes the left camera pixel array 34 at the location y^i_L, Z^i_L. These positions are applied to an absolute coordinate system; see the process described in col. 7, lines 13-46 of McDowell.);

measuring a respective displacement of said first and second corresponding correlating interrogation areas in the first and second images using optical cross-correlation in order to determine the imaging equation (The pixel locations x^i_R, Z^i_R and y^i_L, Z^i_L are correlated to match an absolute coordinate system.);

determining point correspondences of the first and second cameras based on the measured respective displacement (see above); and

determining the imaging equation, including the imaging function M, for the first and second cameras by means of an approximation method, using known internal and external camera parameters and the point correspondences and the displacement of respective interrogation areas (An imaging formula is found based on the calibration described in col. 6, line 66 – col. 7, line 54 and based on external camera parameters such as focal lengths of the left and right cameras f_L and f_R, and using a least squares data fitting approximation method such that the absolute coordinate x_j, y_j, z_j can be determined with only its pixel positions $(x^j_R, Z^j_R)(y^j_L, Z^j_L)$ on the cameras; see col. 7, lines 47-54); and

applying said imaging equation during a stereo PIV procedure on flowing particles of the visualized flow (The absolute coordinate x_j, y_j, z_j of a tracer particle in a flow can be determined with only its pixel positions $(x^j_R, Z^j_R)(y^j_L, Z^j_L)$ on the cameras);

but is silent regarding wherein the two images are taken simultaneously. McDowell teaches wherein the left camera view and the right camera view are calibrated separately. This teaching does not preclude the calibrations from happening simultaneously. In fact, McDowell teaches that the cameras can record the two views simultaneously during operation (col. 5, lines 9-10; col. 13, line 65-col. 14, line 10). Therefore, it would have been obvious to one of ordinary skill in the art to have performed the calibration simultaneously for quick operation.

As to claim 2, McDowell et al. teaches the method according to claim 1, wherein the internal camera parameters include focal length (col. 7, lines 18-19 and 35-36), position

of optical axes (x_0, y_0) (col. 6, lines 29-36) and distortion parameters of camera optics (e.g. “camera aberrations”; see col. 4, line 2).

As to claim 3, McDowell et al. teaches the method according to claim 1, wherein the external parameters include position and orientation of the cameras relative to each other (col. 3, lines 18-20).

As to claim 4, McDowell et al. teaches the method according to claim 1, wherein if position of the illuminated section relative to a coordinate system of a known imaging equation is unknown, the position of the illuminated section is determined using the point correspondences (col. 3, lines 35-39).

As to claim 5, McDowell et al. teaches the method according to claim 1, wherein if one or several of the internal camera parameters are known, other ones of the internal and external camera parameters are determined using the point correspondences in order to thus determine the imaging equation (col. 7, lines 55-65).

As to claim 6, McDowell et al. teaches the method according to claim 1, wherein the self-calibration process further comprises:

- taking two or more camera images respectively by the first and second cameras at sequential times t_0 to t_n (col. 12, lines 33-36),

- determining a two-dimensional correlation function c_0 (dx, dy) to c_n (dx, dy) by means of optical cross-correlation at each time t_0 to t_n using corresponding ones of the images (centroid determination col. 9, lines 30-46),
- adding up the correlation functions c_0 to c_n (Eq. 1);
- determining correlation peaks and a highest correlation peak, and
- determining the displacement dx, dy of the respective one of the interrogation areas and, as a result thereof, the point correspondences being determined after based on the determination of the highest correlation peak (A global-optimization scheme, e.g. GESA algorithm in col. 13, lines 30-41, determines the best match of the tracer particle tracks, i.e. correlation peaks, and point correspondences are determined; col. 12, line 66-col. 13, line 12).

As to claim 9, McDowell et al. teaches the method according to clam 1, wherein each of the first and second cameras takes in short succession two images and that additional point correspondences are determined using a cross-correlation between the images at the times t and t+dt (col. 5, lines 41-54).

As to claim 10, McDowell et al. teaches the method according to claim 1, wherein optical axes of the first and second cameras are disposed coplanar to each other. (i.e., When the principal optical axes "Z_1 and Z_2" of the two cameras are equal.) (See col. 6, lines 39-50.)

5. Claims 7 and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over McDowell et al. (US 5,905,568) in view of Meng, Xiaoqiao and Hu, Zhanyi “A new easy camera calibration technique based on circular points,” previously cited in Office Action mailed 19 August 2008.

As to claim 7, McDowell et al. teaches the method according to claim 1, but does not teach wherein the approximation method is based on the Levenberg-Marquardt algorithm.

Meng, Xiaoqiao and Hu, Zhanyi “A new easy camera calibration technique based on circular points.” (Meng and Hu) teaches wherein the approximation method is based on the Levenberg-Marquardt algorithm (section 2.2 of Meng and Hu).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have used the Levenberg-Marquardt algorithm of Meng and Hu with the method of McDowell et al. to “optimize a cost function by solving with a standard optimization algorithm.” (see section 2.2 of Meng and Hu).

As to claim 8, Elder et al. teaches wherein the RANSAC algorithm is superimposed on the Levenberg-Marquardt algorithm (section 2.3 of Meng and Hu).

6. Claims 11 and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over McDowell et al. (US 5,905,568) in view of Raffel et al. (US 5,610,703), previously cited in Office Action mailed 19 August 2008.

As to claim 11, McDowell et al. teaches the method according to claim 6, but does not teach wherein a section thickness of illuminated sections corresponding to respective timing of the images is determined through a width of the correlation peaks and a geometrical factor and that, together with the position of the illuminated sections in space, said thickness serves to determine an overlap between the illuminated sections and whether they are suited for PIV measurement.

Raffel et al. teaches wherein a section thickness (e.g., light sheet thickness; col. 6, line 54) of illuminated sections corresponding to respective timing of the images is determined through a width of the correlation peaks and a geometrical factor and that, together with the position of the illuminated sections in space, said thickness serves to determine an overlap between the illuminated sections and whether they are suited for PIV measurement. (see col. 6, lines 47-56).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have used the overlap determination of Raffel et al. with PIV imaging method of McDowell et al. so that “the ambiguity of the sign of the out-of-plane velocity component can be removed.” (See col. 6, lines 59-61 of Raffel)

As to claim 14, this claim differs from claim 11 only in that the limitation “image geometry” is recited in place of “a geometrical factor.” Thus claim 14 is analyzed as previously discussed. Raffel et al. clearly teaches “image geometry” (e.g., interrogation windows; see col. 6, lines 31-40).

7. Claims 12 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over McDowell et al. (US 5,905,568) in view of Walker, Stephen "Two-Axis Scheimpflug Focusing for Particle Image Velocimetry," previously cited in Office Action mailed 19 August 2008.

As to claim 13, McDowell teaches the method according to claim 5, but does not teach wherein if a Scheimpflug adapter is used and with assumption that said Scheimpflug adapter is optimally adjusted, an angle between a camera chip and a main axis and a position of a principal point on the camera chip are computed from the external image parameters and need not be fitted as a result thereof.

Walker, Stephen "Two-Axis Scheimpflug Focusing for Particle Image Velocimetry" (Walker) teaches wherein if a Scheimpflug adapter is used and with assumption that said Scheimpflug adapter is optimally adjusted, an angle between a camera chip and a main axis and a position of a principal point on the camera chip are computed from the external image parameters and need not be fitted as a result thereof (see Section 2.1, Fig. 1a, and Fig. 1b of Walker).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have used the Scheimpflug adapter of Walker with the method of McDowell et al. to “permit focusing on a plane from a non-orthogonal position relative to the plane of measurement.” (See Section 1 of Walker.)

As to claim 12, Walker teaches wherein with assumption of focusing on the particles in the illuminated section during the approximation method, an image width is calculated as a function of focal length of objectives of the two cameras and of a spacing between the illuminated section and the two cameras and needs not be fitted as a result thereof (see equation (1) of Walker).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to CHIA-WEI A. CHEN whose telephone number is (571)270-1707. The examiner can normally be reached on Monday - Friday, 7:30 - 17:00 EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner’s supervisor, Lin Ye can be reached on (571) 272-7372. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Tuan V Ho/
Primary Examiner, Art Unit 2622

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